

## **TITLE: HEAT RECOVERY VENTILATOR**

### **FIELD OF THE INVENTION**

This invention relates to air exchange ventilators for admitting fresh air into an enclosure while exhausting stale air. More particularly, this invention relates to such ventilators which  
5 include a heat exchanger to extract heat from the stale air and transfer it to the fresh air. Still more particularly, this invention relates to defrost arrangements for such ventilators.

### **BACKGROUND OF THE INVENTION**

Highly energy efficient buildings are generally designed to avoid uncontrolled ingress or egress of air. As some air exchange is necessary to remove stale air and replace it with fresh air,  
10 it is desirable to first remove heat from the stale air to avoid losing the heat with the air. A heat recovery ventilator is used for this purpose.

A heat recovery ventilator includes a heat exchanger with two discrete air passageways, one for stale air exhaust and the other for fresh supply air. As the exhaust air passes out of the enclosure through the heat exchanger, it gives up its heat to the fresh supply air entering the  
15 enclosure through the heat exchanger. Accordingly the heat is "recovered" in the ventilator during the ventilation process and hence the name "heat recovery" ventilator.

A problem occurs with heat recovery ventilators in situations where the fresh supply air is at below freezing temperatures. As the stale air generally contains moisture, once it passes up heat, the moisture will freeze in the stale air exhaust passageway. Eventually ice build-up will  
20 block the passageway preventing the exhausting of stale air.

Different mechanisms have been proposed in order to defrost the ventilator, for example, as disclosed in Canadian Patent No. 2,059,195 and Canadian Patent No. 2,140,232. According to the latter, two actuators and respective valves or flaps are used to close the exhaust outlet and fresh supply air inlet. Stale air is thereby redirected to return back through the fresh supply air  
25 passageway to defrost the stale exhaust air passageway. This is carried out periodically, typically before the passageways totally freeze up. A drawback to this arrangement is the cost and complexity associated with utilizing two actuators each controlling separate valves or flaps.

The former patent suggests that instead of having two actuators it is possible to block the cold supply inlet and divert stale air exhaust back through the fresh supply air passages in the heat exchanger. While this does eliminate a valve or flap and an actuator it does present its own problems. As the actuator and flaps are disposed adjacent the cold supply there is a possibility of  
5 their freezing, thereby rendering them inoperable. Furthermore while the fresh air supply is closed stale air is recirculated. It would be preferable if the unit were capable of admitting at least some fresh supply air to commingle with the stale air.

## SUMMARY OF THE INVENTION

A heat recovery ventilator is provided which includes a heat exchanger having discrete  
10 inlet and exhaust passageways extending therethrough for providing heat transfer between respective fluids flowing along the inlet and the exhaust passages. The inlet passageway provides fluid communication between a supply inlet plenum and a supply discharge plenum having a supply discharge port for discharging supply air. The outlet passageway provides fluid communication between an exhaust inlet plenum having an exhaust inlet port and an exhaust  
15 discharge plenum. The supply inlet plenum has a supply port for admitting supply air into the supply inlet plenum. The exhaust discharge plenum has an exhaust port for discharging air from the exhaust discharge plenum. A transfer port extends between the supply inlet plenum and the exhaust discharge plenum for providing fluid communication therebetween. A flow diverter is associated with the transfer port and is movable between a venting configuration closing the  
20 transfer port to allow fluid flow through the exhaust discharge port and a defrost configuration closing the exhaust discharge port to open the transfer port.

The exhaust passageway may include a plurality of individual adjacent passageways through the heat exchanger. Furthermore the inlet passageway may include a plurality of individual adjacent passageways through the heat exchanger.

25 The supply inlet plenum, supply discharge plenum, exhaust inlet plenum and exhaust discharge plenum may be at least partially defined by a housing containing the heat exchanger.

Fluid flow along the exhaust passageway may be augmented by an exhaust fan mounted within either the exhaust inlet plenum or the exhaust discharge plenum.

Fluid flow along the inlet passageway may be augmented by a supply discharge fan mounted within the supply discharge plenum. The exhaust inlet and supply discharge fans may be of similar capacity.

The exhaust inlet and discharge fans may share a common fan motor.

- 5        The heat recovery ventilator may further have an actuator operably connected to the flow diverter for moving the flow diverter between its venting and discharge configurations.

The actuator may communicate with a controller which causes the actuator to move.

## DESCRIPTION OF DRAWINGS

- Preferred embodiments of the invention are described below with reference to the  
10 accompanying drawings in which:

Figure 1 is a perspective view of an interior of a heat recovery ventilator according to the present invention in the ventilation mode;

Figure 2 is a view corresponding to Figure 1 but showing the heat recovery ventilator in a defrost mode;

- 15        Figure 3 is a perspective view of an interior of an alternate embodiment heat recovery ventilator according to the present invention in its ventilation mode;

Figure 4 is a view corresponding to Figure 3 but showing the heat recovery ventilator in a defrost mode;

- Figure 5 is a perspective view corresponding to Figure 1 but illustrating an alternative fan  
20 motor placement and shown in a ventilation mode; and,

Figure 6 is a view corresponding to Figure 5 but illustrating the ventilator in a defrost mode.

## DESCRIPTION OF PREFERRED EMBODIMENTS

A heat recovery ventilator according to the present invention is generally indicated by reference 10 in the accompanying illustrations. At the core of the heat recovery ventilator 10 is a heat exchanger 12 having an inlet passageway schematically illustrated by arrow 20 and an exhaust passageway schematically illustrated by arrow 30. A housing 14 defines an exterior of the heat recovery ventilator 10. It will be appreciated that the actual unit will have a front cover which is not shown in Figures 1 and 2 to show its interior.

The inlet passageway 20 and exhaust passageway 30 are "discrete" in that they allow heat transfer between respective fluids flowing therealong without allowing commingling of the fluids. As is common with air to air heat exchangers, at least one of the inlet passageway 20 and exhaust passageway 30 may comprise a plurality of individual passageways, such as shown at reference 32. This maximizes the surface area to enhance heat transfer.

The inlet passageway provides fluid communication between a supply inlet plenum 24 and a supply discharge plenum 26. The outlet passageway provides fluid communication between the exhaust inlet plenum 34 and exhaust discharge plenum 36.

The supply inlet plenum has a supply port 25 for admitting supply air 28 (typically "outside" air) into the supply inlet plenum 24.

The supply discharge plenum 26 has a supply discharge port 27 for discharging air 20 which has passed through the heat exchanger 12 from the heat recovery ventilator 10 into an enclosure.

The exhaust discharge plenum 36 has an exhaust port 37 for discharging exhaust air 39 from the exhaust discharge plenum 36. The exhaust inlet plenum 34 has an exhaust inlet port 35 for admitting warm air 38 from an enclosure into the exhaust inlet plenum 34.

A dividing wall 40 separates the supply inlet plenum 24 from the exhaust discharge plenum 36. A transfer port 42 extends between the supply inlet plenum 24 and the exhaust discharge plenum 36 to provide fluid communication therebetween in a discharge mode.

A flow diverter 44 such as the movable flap illustrated is associated with the transfer port 42 for example by being mounted to the dividing wall 40 or the housing 14 which contains the heat exchanger 12 and at least partially defines the supply inlet, supply discharge, exhaust inlet and exhaust discharge plenums 24, 26, 34 and 36 respectively. The flow diverter 44 is movable  
5 between a venting configuration illustrated in Figure 1 and a defrost configuration illustrated in Figure 2. In the venting configuration the flow diverter 44 closes the transfer port 42 and opens the exhaust discharge port 37 and allows fluid flow (i.e. exhaust air 39) to flow through the exhaust discharge port 37. In the defrost configuration the flow diverter 44 opens the transfer port 42 and closes the exhaust discharge port 37 to cause air from the exhaust discharge plenum  
10 36 to be transferred to the supply inlet plenum 24.

In order to augment air flow along the exhaust passageway 30, an exhaust fan 50 may be mounted within the exhaust inlet plenum 34. If a centrifugal type of fan is utilized as illustrated in Figures 1 and 2, appropriate partitioning such as provided by partition wall 52 or suitable ducting will be required to separate an inlet 54 of the fan 50 from a fan outlet 56. In this manner  
15 a pressure differential may be maintained across the exhaust inlet plenum 34.

To augment air flow along the inlet passageway 20, a supply discharge fan 60 may be mounted within the supply discharge plenum 26 to cause a pressure gradient across the supply discharge plenum 26 between the heat exchanger 12 and the supply discharge port 27.

Providing an exhaust fan 50 and a supply discharge fan 60 within the housing 14 is  
20 desirable in order to make the heat recovery ventilator 10 a "stand alone" unit. It will however be appreciated that external fans might also be connected to the inlet port 35 and supply discharge port 27.

If an exhaust fan 50 and a supply discharge fan 60 are provided, these should be of similar capacity and may be arranged as illustrated to share a common fan motor 70. In this  
25 manner air flow through the inlet passageway 20 will balance air flow through the exhaust passageway 30 to substantially avoid unwanted pressure differentials between an outside and an inside of an enclosed space utilizing the heat recovery ventilator 10.

In the embodiment illustrated in Figures 1 and 2, the fan motor 70 is shown in the supply discharge plenum 26. Alternatively, as illustrated in Figures 5 and 6, the fan motor 70 may be mounted in the exhaust inlet plenum 34. Performance testing has indicated that improvements in efficiency may be realized by the latter arrangement wherein the fan motor is in the exhaust air stream rather than in the supply air stream.

An actuator 80 such as a servomotor may be operably connected to the flow diverter 44 to cause it to move between its venting and defrost configurations. Other arrangements may also be utilized such as fluid pressure actuated cylinders. A controller 90 may be connected so as to communicate with the actuator 80 to cause the actuator to move. The controller 90 may take a variety of forms and for example may be a timer or alternatively may sense temperature or air flow within various parts of the heat recovery ventilator 10.

In operation, when the heat recovery ventilator 10 is in its ventilation mode as illustrated in Figure 1, warm exhaust air 38 enters the inlet port 35, follows the exhaust passageway 30 and is exhausted through the exhaust port 37. Simultaneously cold supply air 28 is drawn into the supply inlet port 25, follows the inlet passageway 20 and is discharged through the supply discharge port 27. In passing through the heat exchanger 12, heat from the warm exhaust air 38 is transferred to the cold supply air 28.

In its defrost mode as illustrated in Figure 2, the exhaust port 37 is closed and the transfer port 42 opened to cause the warm exhaust air 38 to enter the inlet passageway 20 in lieu of cold supply air 28 thereby heating the heat exchanger 12 to cause any accumulated ice to melt.

As the flow diverter 44 and the actuator 80 are within the exhaust discharge plenum 36 they are typically in a non-freezing environment which might not be the case were they mounted in the supply inlet plenum 24. Accordingly the possibility of failure of the heat recovery ventilator through freezing of the actuator 80 and flow diverter 44 is reduced.

The Figures 3 and 4 embodiment is similar to the Figures 1 and 2 embodiment and accordingly the same reference numerals have been used as applicable. The Figures 3 and 4 embodiment differs from the Figures 1 and 2 embodiment principally in the fan ducting and placement and in port placement.

As illustrated in Figure 3, the exhaust discharge plenum 36 includes an exhaust duct 39 which fluidly communicates with the exhaust discharge port 37. The transfer port 42 is mounted in this portion of the exhaust discharge plenum 36. Rather than mounting the exhaust fan 50 in the exhaust inlet plenum 34, it is mounted in the exhaust duct portion 39 of the exhaust discharge  
5 plenum 36. Accordingly the exhaust fan 50 draws rather than pushes warm exhaust air through the heat exchanger 12.

The supply discharge fan 60 is similarly mounted in a supply discharge duct 29 which forms a continuation of the supply discharge plenum 26 and extends to the supply discharge port 27. As with the Figures 1 and 2 embodiment the supply discharge fan 60 draws either cold  
10 supply air (ventilation mode – Figure 3) or warm exhaust air (exhaust mode – Figure 4) through the inlet passageway of the heat exchanger 12. In either case it discharges through the supply discharge port 27.

The use of the supply discharge duct 29 and exhaust duct 39 allows the supply port 25, supply discharge port 27, exhaust inlet port 35 and exhaust port 37 to all be on a common side of  
15 the heat recovery ventilator 10. Initial testing has shown the Figures 3 and 4 embodiment to have better heat recovery efficiency than the Figures 1 and 2 embodiment.

The above description is intended in an illustrative rather than a restrictive sense. Variations may be apparent to those skilled in such apparatus without departing from the spirit and scope of the invention as defined by the claims set out below. For example although the unit  
20 has been described for use with air, the same principles might find application for use with other fluids.